Joining inner space to outer space

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Abstract

The purpose of this paper is to demonstrate that it is possible, in principle, to obtain knowledge of the entire universe at the present time, even if the radius of the universe is much larger than the radius of the observable universe.

1 The construction

Cosmologist George Ellis states that "Our view of the universe is limited by the visual horizon, comprised of the worldlines of [the] furthest matter we can observe - namely, the matter that emitted the CBR [Cosmic Background Radiation] at the time of last scattering. . . Visual horizons do indeed exist, unless we live in a small universe, spatially closed with the closure scale so small that we can have seen right around the universe since decoupling," (Ellis 2007, section 2.4.2). He asserts that "Claims about what conditions are like on very large scales - that is, much bigger than the Hubble scale - are unverifiable, for we have no observational evidence as to what conditions are like far beyond the visual horizon," (ibid., section 4.3). The purpose of this paper is to devise a model of our universe in which these assertions would be false.

Let us begin by making the following assumptions:

1. The Friedmann-Robertson-Walker models of general relativistic cosmology are correct, but the spatial universe in these models is a 3-dimensional compact manifold-with-boundary Σ. Compactness entails that the spatial universe is of finite volume, (see Cornish and Weeks, 1998).

2. The radius of the spatial universe at the current time is many orders of magnitude greater than the radius of the observable spatial universe.

3. In particle physics, string theory is false, but the preon hypothesis is correct in the sense that there is only one type of ultimate elementary particle. Hence, all the quarks and leptons, all the gauge bosons, and all the Higgs bosons (if they exist), are ultimately composed of preons (see Bilson-Thompson *et al*, 2006), and the standard model emerges from the theory of preons.

The model universe I wish to propose is one in which outer space is joined to inner space, in the sense that each elementary particle contains the universe to which the elementary particle itself belongs. This is perfectly well-defined topologically.

Let us suppose that each preon has a Compton wavelength[1] of r. The Compton wavelength can be thought of as the length scale at which relativistic quantum field theory becomes relevant for a particle. Hence, as a first approximation which neglects quantum field theory, let us represent each preon as a solid ball $\mathbb{D}_i(r)$ of radius r, embedded in 3-dimensional space Σ. Given the assumption that the spatial universe is of finite volume, there will be a finite number N of preons in the universe, so they can be enumerated $i = 1, ..., N$. Under the approximation made here, the boundary of each preon is homeomorphic to the 2-sphere, $\partial\mathbb{D}_i \cong S^2, \ i = 1, ..., N$. Let us also suppose that the boundary of large-scale 3-dimensional space is homeomorphic to the boundary of each preon, which in this case is the 2-sphere, so that $\partial\Sigma \cong S^2$.

Now excise from Σ the interior of each solid ball $\mathbb{D}_i$. This means taking the complement $\Sigma_\flat = \Sigma - \bigcup_i \text{Int}(\mathbb{D}_i)$. So doing obtains a 3-manifold-with-boundary $\Sigma_\flat$ containing numerous 'holes'.

Now identify the original boundary $\partial\Sigma$ with the boundary of each hole $\partial\mathbb{D}_i$, to obtain a quotient topological space $\Sigma_\sharp$. In other words, define N bijective identification maps $\phi_i : \partial\Sigma \to \partial\mathbb{D}_i$, and introduce an equivalence relationship $\mathscr{R}$ which treats $p \in \partial\Sigma$ as equivalent to each $\phi_i(p) \in \partial\mathbb{D}_i$ for $i = 1, ..., N$. Points not belonging to any component of the boundary of $\Sigma_\flat$ are each treated as an equivalence class containing a single member. The quotient space is the set of all equivalence classes, $\Sigma_\sharp = \Sigma_\flat/\mathscr{R}$. There is a projection mapping from $\Sigma_\flat$ onto $\Sigma_\sharp$, and the quotient topology is defined to be the largest topology one can bestow on $\Sigma_\sharp$ which still permits the projection mapping to be continuous.

In such a space-time, each elementary particle is simply an embedding of the universe within itself. If one tries to probe the inside of an elementary particle, then one is probing inside the entire universe, for the boundary of the elementary particle (preon) is also the outer-most boundary of large-scale space-time. In such a universe, one really can see the universe in a grain of sand.

If such were the case, then we would effectively have both an internal perspective on the universe, extending out to the conventional visual horizon, and we would potentially have an external perspective, which would allow us to see regions of space beyond our conventional visual horizon. Our observations would still be restricted to the past light cone, but if the past light cone included an elementary particle, as defined here, then the information stored within such an elementary particle would include everything there is to know about the universe, and would therefore provide us, in principle, with knowledge of those parts of the universe which lie beyond the radius of the observable universe, as conventionally defined.

[1] The Compton wavelength of a particle of mass m is h/mc, where h is Planck's constant, and c is the speed of light.

References

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